



66722-057-7

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:) PATENT
Steen Barbrand Rasmussen) Confirmation No. 3799
Serial No.: (PCT/DK03/00011)) Customer No.: 25269
10/501,224)
Filed: (10 Jan. 2002))

For: PIEZO ELECTRIC PUMP AND DEVICE WITH SUCH PUMP

SECOND RENEWED PETITION UNDER 37 C.F.R. §1.47(b)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

January 24, 2006

Sir:

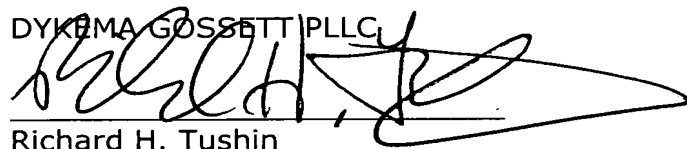
Referring to the Decision on Renewed Petition, dated July 28, 2005, the undersigned herewith submits a supplemental legal opinion prepared by Troels Libak Stollberg which concludes (with supporting evidence) that Steen B. Rasmussen coinvented the subject matter of this application while employed by Rhinometrics A/S, and that his interest has been transferred to Interacoustics A/S.

Based on this supplemental legal opinion, it is asserted that this petition should be granted.

Respectfully submitted,

DYKEMA GOSSETT PLLC

By:


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TO WHOM IT MAY CONCERN

Smørum, 24 January 2006

TLS/

Legal opinion – Further on ownership of IPR created by Mr. Steen B. Rasmussen during employment in the William Demant Holding Group

In my capacity as Vice President, Legal Affairs, of William Demant Holding A/S as well as advocate admitted to the Danish Bar I hereby render the following legal opinion. :

- Initially I reconfirm my legal opinion of 12 July 2005 (**Appendix 1**), which still as per today is corresponding to applicable Danish law. For both legal opinions I declare under penalty of perjury under the laws of the United States of America that the legal opinions are true and correct. Furthermore I am over the age of eighteen and suffering from no physical or mental impairments that preclude me from understanding my statements and I am providing the declarations based on my personal knowledge and the original documentation at hand and with authority to speak on behalf of William Demant Holding A/S and its wholly owned subsidiaries, Rhinometrics A/S, Oticon A/S and Interacoustics A/S. Interacoustics A/S is the same legal entity as Interacoustics A/S, Assens; the latter being a trading name.
- Taking into consideration the decision from the United States Patent and Trademark Office 28 July 2005 in the matter US Application No. 10/501,224 regarding PCT No. PCT/DK03/00011 I make the following additional statements:
- The Danish Employee Inventions Act ("Lov om arbejdstageres opfindelser") of 18 March 1986 as amended 26 February 1992 is attached as **Appendix 2** duly translated into English by a publicly certified translator. Section 5 hereof regulates the transfer of intellectual property made during employment as further detailed in my legal opinion of 12 July 2005.
- The judgment – as mentioned in my legal opinion of 12 July 2005 - by the Danish Maritime- and Commercial Court of 20 May 2005 in favour of our Danish subsidiary, Oticon A/S has not been translated to English as per now, as it was only meant as an example of the current Danish case law. However if desired by the United States Patent and

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Trademark Office, we would shortly be able and willing to provide the judgment in an official translation.

- On 8 January 2002 Mr. Steen B. Rasmussen assigned all rights to the invention "Piezo electric pump and device with such pump" to our Danish subsidiary Interacoustics A/S, Assens. The assignment was made on the standard form provided by the official Danish Patent- og Varemærkestyrelse ("The Danish Patent and Trade Mark Office", www.dkpto.dk) and is attached as **Appendix 3**. This assignment was made during his period of employment 1 July 1996 – 30 November 2003 with one of our other Danish subsidiaries, Rhinometrics A/S. The specific assignment is thus in full compliance with the Danish Employee Inventions Act. As both Rhinometrics A/S and Interacoustics A/S, Assens are wholly owned subsidiaries within the William Demant Holding group, the assignment was made directly to Interacoustics A/S, Assens, with Rhinometrics A/S acceptance.
- The above assignment (Appendix 3) corresponds with respect to the invention and patent in question to the Patent application No. PA 2002 00038 of 10 January 2002 (confirming, official transcript from Patent- og Varemærkestyrelsen of 10 August 2005 is attached as **Appendix 4**) as well as the undated PCT request (**Appendix 5**) signed by Mr. Steen B. Rasmussen and Mr. Leif Pedersen, the managing director of Interacoustics A/S, Assens. The PCT request (Appendix 5) has the international filing date 9 January 2003 according to the stamp (**Appendix 6**) of the Danish Patent and Trade-mark Office, acting as receiving office to WIPO. WIPO has today per phone promised to forward to me a copy of their receipt of Appendix 6.
- Appendices 3 and 5 evidence the fact that the invention was derived by Mr. Rasmussen while an employee of Rhinometrics A/S.
- Based on the above the ownership to the pending applications PCT DK03/00011 and PA 2002 00038 as well as the underlying inventions belongs to Interacoustics A/S, Assens. The expedition of the above patent applications, including registrations and renewals, does under Danish law not need further signatures from Mr. Steen B. Rasmussen. Appendices 3, 4 and 5 would be sufficient for a Danish court to confirm/award ownership of US Patent Application No. 10/501,224 to Interacoustics A/S, Assens under the Danish Employees Inventions Act.

Please feel free to contact me for any questions or comments at +45 3913 8209 or tls@demant.dk. Our headquarters have moved to a new address: Kongebakken 9, DK – 2765 Smørum, Denmark; all other contact details remain unchanged.

Yours sincerely

William Demant Holding A/S



Troels Libak Stollberg, advokat
Vice President, Legal Affairs

4/1/05

TO WHOM IT MAY CONCERN

Hellerup, 12 July 2005
TLS/

Legal opinion - Ownership of IPR created by Mr. Steen B. Rasmussen during employment in the William Demant Holding Group

In my capacity as Vice President, Legal Affairs, of William Demant Holding A/S as well as advokat admitted to the Danish Bar I hereby render the following legal opinion:

- William Demant Holding A/S ("WDH") is a Danish company, listed in the top-20 KFX-index of the Copenhagen Stock Exchange. Rhinometrics A/S, Oticon A/S and Interaoustics A/S, Assens are wholly owned Danish subsidiaries of WDH. Further on WDH's corporate structure can be found at www.demant.com
- WDH acquired Rhinometrics A/S in 1996. Mr. Steen B. Rasmussen, civil engineer of education, was employed as managing director of Rhinometrics A/S effective 1 July 1996. His employment agreement had no individual regulation on intellectual property rights. The agreement was terminated by WDH effective 30 November 2003.
- Inventions made by employees in Danish companies – no matter their position – are regulated by the Danish Employee Inventions Act ("Lov om arbejdstageres opfindelser") of 18 March 1986 as amended 26 February 1992. The employer is according to section 5 hereof entitled to ask the employee to transfer the ownership globally of any invention made within the employee's field of work. Furthermore the employee is not entitled to any remuneration for such transfer, in case the value of the inventions does not exceed what with fairness could be expected performed by the employee in his position. Under general Danish legal principles the ownership can be assigned by the employer at the employer's discretion.
- The Danish Maritime and Commercial Court ("Sø- og Handelsretten") in Copenhagen on 20 May 2005 voted in favour of Oticon A/S fully releasing the WDH-subsiary from a claim by a former engineer based on the Danish Employee Inventions Act section 8. Even though any court decision is specific the judgment is representative for the current Danish case law.

- Mr. Steen B. Rasmussen during his employment with Rhinometrics A/S accepted to let some of his inventions be patented in the name of a sister company within the WDH-group, Interacoustics A/S, Assens, including the pending applications PCT DK03/00011 and PA 2002 00038
- Based on the above the ownership to the pending applications PCT DK03/00011 and PA 2002 00038 as well as the underlying inventions belongs to Interacoustics A/S, Assens. The expedition of the above patent applications, including registrations and renewals, does under Danish law not need a signature from Mr. Steen B. Rasmussen.

Please feel free to contact me for any questions or comments at +45 3913 8209 or tls@demant.dk

Yours sincerely
William Demant Holding A/S

Troels Libak Stollberg, advokat
Vice President, Legal Affairs

Executive order no. 131 of 18 March 1986

Act on employees' inventions

as amended by Act no. 130 of 26 March 1992

S. 1.(1) For the purposes of this Act the word 'inventions' shall solely include inventions that are patentable in the Danish realm and devices that can be registered as utility models in the Danish realm.

(2) The word 'employee' shall comprise any person in public or private employment.

(3) Teachers and other scientific staff at universities and other higher education institutions shall not in their capacity as teachers or scientific staff be considered employees and shall be fully entitled to the inventions conceived by them unless otherwise decreed by law or agreement.

S. 2- Provided the provisions of this Act have not explicitly been declared mandatory, the provisions of this Act shall be applicable only in the absence of any agreement or arrangement to the contrary.

S. 3.- Unless otherwise stipulated by this Act or any other act, an employee shall be entitled to the inventions made by such employee.

S. 4.- ---

S. 5- If an employee has made an invention considered as having been conceived in the course of his employment, and if the use of such invention falls within the field of his employer's activities, such employer shall be entitled to demand that the right in the invention be transferred to the employer for one or more countries. The employer shall be equally entitled where the use of the invention does not fall within the field of his activities, if the employee's invention is made in the course of a duty specifically assigned to the employee by the employer.

S. 6.- An employee inventor comprised by the provisions of s. 5 above shall be obliged without undue delay to notify his employer of the invention providing such information of the invention as enables the employer to assess the importance of the invention.

S. 7. (1) If an employer wishes to acquire the right to an invention as stipulated in s. 5 above, he shall notify the employee hereof within four months of his receipt of the notification referred to in s. 6.

(2) Before expiry of the above time limit, the employee shall not without the employer's written consent make arrangements in respect of the invention or disclose it to any third party in such a way that it can be made public or exploited by someone else for someone else's account. This provision shall however not apply if the employer has declared in writing that he is not interested in the invention.

(3) Even if the above time limit has not expired, the employee may, as soon as he has notified his employer as mentioned in s. 6 above, apply for a patent for the invention or registration of the device, but in such case he must first notify his employer hereof. The employee cannot in advance renounce such right.

S. 8 (1) If an employer acquires the right to an invention made by an employee in compliance with s. 5 or on some other basis, the employee inventor shall, even if an agreement has been made to the contrary, be entitled to reasonable compensation unless the value of his invention does not exceed what might reasonably be expected to result from the carrying out of his duties.

(2) On fixing of an award of compensation, the relevant considerations are in particular the value of the invention and its benefit to the employer's undertaking, the employee's terms of

employment and the significance of the employee's duties in relation to the invention.

(3) The statutory time limit for a claim for fixing of an award of compensation is five years in compliance with Act no. 274 of 22 December 1908, the statutory time limit running from the date when the employer announced his wish to acquire the invention.

(4) Although otherwise agreed, provisions or agreements concerning compensation may subsequently be revised at the request of either party, if the determining factors have changed materially or other special considerations speak in favour of such revision. However compensation or benefits received by the employee based on a previous award of compensation shall never be returned by virtue of the provision above.

S. 9.- If within six months of an employee leaving his employment, such employee applies for a patent for an invention or registration of a utility model made by him, which, had it been conceived during his employment, would have been subject to the provisions of s. 5 above, such invention shall be presumed to have been conceived during his employment unless he can prove that the invention was conceived after termination of his employment.

S. 10.- An agreement between an employer and an employee for the purpose of restricting the employee's entitlement to make arrangements in respect of inventions conceived more than a year after termination of the employment shall be invalid.

S. 11.- (Repealed).

S. 12. (1) A person who by virtue of the provisions of this Act obtains knowledge of an invention shall not without sanction utilise such knowledge obtained in such manner or wrongfully disclose any information about such invention.

(2) Deliberate breach of this provision or of the provision stipulated in s. 7(2) is punishable with a fine or mitigated imprisonment. Fines shall accrue to the Treasury.

(3) Prosecution will be instituted at the request of the aggrieved party.

S. 13.- ---

S. 14.- (Repealed).

Act no. 130 of 20 February 1992 by which ss. 1, 7 and 9 were extended to comprise utility models includes the following clauses relating to commencement:

S. 52. (1) The Act shall become effective on 1 July 1992, cf. however subsection 2 below.

(2) The rule stipulated in s. 6(1) shall only be applicable if an application for a patent has been submitted after the date of commencement of this Act.

(3) Sections 4(2) and 33(2-4) shall become effective on the date of commencement of the Agreement relating to Community patents. The Minister of Industry shall draw up an executive order in respect hereof.

S. 53.- This Act does not extend to the Faroe Islands and Greenland, but can be extended by Royal Decree subject to such adaptation as may be required by the circumstances peculiar to the Faroe Islands and Greenland.



Lovbekendtgørelse 1986-03-18 nr. 131

Lov om arbejdstageres opfindelser,

som ændret ved L 1992-02-26 nr. 130

§ 1. Ordet »opfindelser« omfatter i denne lov kun opfindelser, der kan patenteres her i riget, og frembringelser, der kan registreres som brugsmodel her i riget.

Stk. 2. Ordet »arbejdstager« omfatter enhver, der er ansat i offentlig eller privat tjeneste.

Stk. 3. Lærere og andet videnskabeligt personale ved universiteter og andre højere læreanstalter anses ikke i denne deres egenskab som arbejdstagere og har den fulde ret til de af dem gjorte opfindelser, medmindre andet måtte være bestemt ved anden lov eller følge af aftale.

§ 2. Denne lovs bestemmelser kommer, for så vidt de ikke udtrykkeligt er erklæret for ufravigelige, kun til anvendelse, hvis ikke andet er eller må anses aftalt.

§ 3. I det omfang, ikke andet følger af denne eller anden lov, har en arbejdstager retten til de af ham gjorte opfindelser.

§ 4. - - -

§ 5. Har en arbejdstager gjort en opfindelse, som han må anses at være nået til gennem sin tjeneste er arbejdsgiveren, såfremt udnyttelsen af opfindelsen falder indenfor hans virksomheds arbejdsområde, berettiget til at kræve retten til opfindelsen overdraget til sig for et eller flere lande. Samme ret har arbejdsgiveren, selvom udnyttelsen af opfindelsen ikke falder indenfor virksomhedens arbejdsområde, hvis arbejdstagerens opfindelse angår en ham af virksomheden stillet, nærmere angiven opgave.

§ 6. En arbejdstager, der har gjort en opfindelse, som omfattes af bestemmelserne i § 5, er pligtig til uden ugrundet ophold at underrette arbejdsgiveren herom under angivelse af sådanne oplysninger om opfindelsen, at arbejdsgiveren sættes i stand til at bedømme opfindelsens betydning.

§ 7. Ønsker en arbejdsgiver at erhverve retten til en opfindelse i henhold til § 5, skal han underrette arbejdstageren herom inden 4 måneder efter at have modtaget den i § 6 nævnte meddelelse.

Stk. 2. Inden udløbet af denne frist må arbejdstageren ikke uden arbejdsgiverens skriftlige samtykke disponere over opfindelsen eller åbenbare den for andre på en sådan måde, at den kan offentliggøres eller udnyttes for andres regning. Dette gælder dog ikke, hvis arbejdsgiveren skriftligt har erklæret at være uden interesse i opfindelsen.

Stk. 3. Selv om den nævnte frist ikke er udløbet, kan arbejdstageren, så snart han har givet sådan meddelelse som i § 6 omhandlet, søge patent på opfindelsen eller registrering af frembringelsen, men han skal i så fald forinden underrette arbejdsgiveren herom. Arbejdstageren kan ikke på forhånd give afkald på denne ret.

§ 8. Erhverver arbejdsgiveren i henhold til § 5 eller på andet grundlag retten til en af arbejdstageren gjort opfindelse, er arbejdstageren, selvom andet måtte være aftalt, berettiget til rimelig godtgørelse, medmindre værdien af opfindelsen ikke overstiger, hvad arbejdstageren under hensyn til sine arbejdsforhold i det hele med rimelighed kan forudsættes at skulle præstere.

Stk. 2. Ved fastsættelsen af godtgørelsen skal hensyn særligt tages til opfindelsens værdi og dens betydning for virksomheden, til arbejdstagerens ansættelsesvilkår samt til den betydning, arbejdstagerens tjeneste har haft for opfindelsen.

Stk. 3. Kravet på fastsættelse af godtgørelse forældes på 5 år i overensstemmelse med lov nr. 274 af 22. december 1908, idet forældelsesfristen regnes fra det tidspunkt, da arbejdsgiveren har tilkendegivet, at han ønsker at erhverve opfindelsen.

Stk. 4. Selv om andet måtte være aftalt, kan bestemmelser eller aftaler vedrørende godtgørelse på forlangende af en af parterne senere ændres, når de forhold, der har været bestemmende, har forandret sig væsentligt, eller andre særlige omstændigheder taler derfor. Der skal dog aldrig i medfør af foranstående bestemmelse finde tilbagegivelse sted af ydelser, som arbejdstageren har modtaget på grundlag af tidligere fastsættelse af godtgørelsen.

§ 9. Søges der inden 6 måneder, efter at en arbejdstager er fratrådt sin tjeneste, patent eller brugsmodelregistrering på en af ham gjort opfindelse, som, hvis den var blevet til, medens tjenesten varede, ville have været omfattet af bestemmelserne i § 5, antages opfindelsen gjort, medens tjenesten varede, medmindre det kan sandsynliggøres, at opfindelsen er blevet til efter tjenestens ophør.

§ 10. En overenskomst mellem en arbejdsgiver og en arbejdstager, gående ud på at begrænse arbejdstagerens ret til at disponere over opfindelser, der gøres senere end et år, efter at tjenesteforholdet er ophørt, er ugyldig.

§ 11. (Ophævet).

§ 12. Den, der som følge af bestemmelserne i denne lov kommer til kundskab om en opfindelse, må ikke uhjemlet udnytte, hvad han på denne måde har erfaret, eller upåkrævet åbenbare noget herom.

Stk. 2. Forsætlig overtrædelse af denne bestemmelse eller af bestemmelsen i § 7, stk. 2, straffes med bøder eller hæfte. Bøder tilfalder statskassen.

Stk. 3. Påtale sker på begæring af den forurettede.

§ 13. - - -

§ 14. (Ophævet).

- - -

Lov nr. 130 af 20. februar 1992, hvorved §§ 1, 7 og 9 udvides til at omfatte brugsmodeller, indeholder følgende ikrafttrædelsesbestemmelser:

§ 52. Loven træder i kraft den 1. juli 1992, jf. dog stk. 2.

Stk. 2. Reglen i § 6, stk. 1, finder kun anvendelse, hvis patentansøgning er indleveret efter lovens ikrafttræden.

Stk. 3. § 4, stk. 2, og § 33, stk. 2-4, træder i kraft samtidig med Aftale om EF-patenter. Industriministeren udfærdiger bekendtgørelse herom.

§ 53. Loven gælder ikke for Færøerne og Grønland, men kan sættes i kraft ved kgl anordning med de afvigelser, som de særlige færøske eller grønlandske forhold tilsiger.

I, the undersigned Marianne Nerving, authorised translator, hereby certify the English text to be a true and faithful translation of the attached document in the Danish language produced to me this 14th day of August 2005.

Witness my hand and official stamp.



Overdragelse/Assignment

Patent



**Patent- og
Varemærkestyrelsen**
Erhvervsministeriet

Helgeshøj Allé 81
2630 Taastrup

Tlf. 43 50 80 00

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Undertegnede (navn og adresse):

The undersigned (name and address):

Steen Brabrand Rasmussen
Birkholmvej 1
3540 Lyngø

som har opfundet (opfindelsens benævnelse og evt. ansøgnings-/patentnummer):

who has made the invention (title and, if possible, application/patent No.):

Piezo electric pump and device with such pump

overdrager herved ejendomsretten til opfindelsen/patentet til:

does hereby assign all rights to the invention/patent to:

Interacoustics A/S, Assens
Drejervænget 8
5610 Assens

Sted/Place: Lyngø

Dato/Date: 8. Jan. 2002

Underskrift/Signature:



Kongeriget Danmark

Patent application No.: PA 2002 00038
Date of filing: 10 January 2002
Applicant: Interacoustics A/S, Assens
(Name and address) Drejervænget 8
DK-5610 Assens
Denmark

Title: Piezo electric pump and device with such pump
(Piezo elektrisk pumpe og indretning med en sådan pumpe)

IPC: A 61 B 5/12; H 04 R 17/00

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed

By assignment dated 08 January 2002 and filed on 10 January 2002, the inventor Steen Brabrand Rasmussen, Birkholmvej 1, DK-3540 Lyngby, Denmark has assigned the invention to Interacoustics A/S, Assens, Drejervænget 8, DK-5610 Assens, Denmark.



Patent- og Varemærkestyrelsen
Økonomi- og Erhvervsministeriet

10 August 2005

Susanne Morsing
Susanne Morsing

TITLE

Piezo electric pump and device with such pump

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AREA OF THE INVENTION

The invention relates to pumps incorporating piezo electric pump element. The invention further relates to a device implementing a pump using the principles of the pump element having piezo electric properties for generating pressure differences.

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BACKGROUND OF THE INVENTION

In audiological equipment a pump is in most cases provided for establishing a pressure difference in the ear canal in relation to the existing atmospheric pressure. This comprises both pressure levels above and below the existing atmospheric pressure. Such pressure difference is e.g. created in connection with acoustic measurement in the ear canal in order to determine whether fluid is present in the middle ear, e.g. in connection with Otitis Media (middle ear inflammation).

20 The audiological equipment commercially available all suffer from the drawback that the pump types used in these are both bulky and in long-term use also unreliable. The size issue leads to instruments that are difficult to handle and the reliability issue leads to mechanical failure and malfunction with unnecessary repair and maintenance costs as well as patient re-examinations as the consequence.

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There is for these reasons a need for improvement in the audiological equipment and the pumps finding use in this equipment.

30 A first objective of the present invention is to provide a measuring device for measurement in the ear canal, which has a more reliable function, especially in long-term use.

A second objective is to provide a pump, which is suitable for use in a measuring device for measurement in the ear canal.

SUMMARY OF THE INVENTION

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According to the invention the first objective is achieved by means of a measuring device as defined in claim 1.

10 The invention will provide a device with a more reliable function and hence reduce the before mentioned drawbacks significantly.

In a preferred embodiment valve elements are provided in connection to the inlet opening and the outlet opening for controlling the inlet and the outlet and where the valve elements have piezo electric properties. This enable the pump to operate at
15 relatively high frequency rates compared to conventional valves.

In a further preferred embodiment the pump is adapted to operate at a frequency above 18 kHz, preferably above 20 kHz. Hereby the operation can take place at a frequency above the normal audible frequency range and hence a more comfortable test may be
20 carried out.

In order to provide an increased safety a pressure operated passive valve element may be provided in connection with the pressurized parts of the device. It is obvious that a too high or too low pressure may have a damaging effect on the patients tympanic membrane
25 and hence may cause hearing damage. The independent safety valve is therefore highly desired and in most cases a required element.

According to the invention the second objective is achieved by means of a pump as defined in claim 6.

30

This aspect of the invention will provide a pump with a more reliable function and hence reduce the before mentioned drawbacks significantly in connection with a device according to the invention and further provide similar advantages in other applications.

By incorporating the valve elements as defined the pump will have the ability of operating at significantly higher frequencies than such pumps normally are capable of doing. This means that a number of applications are in reach, which hitherto have not been accessible.

The pump may in a preferred embodiment be adapted to operate at a frequency above 18 kHz, preferably above 20 kHz

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BRIEF DESCRIPTION OF THE DRAWINGS

- 15 FIG. 1 is a schematic drawing showing the pump according to the invention in a top view;
FIG. 2 is a schematic drawing showing the pump in FIG. 1 in a side view;
FIG. 3 is a schematic drawing showing the pump in FIG. 1 in a sectional view along the line A in FIG. 1
20 FIG. 4 is a schematic drawing showing a device according to the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1 the pump according to the invention comprises a housing 7, 8 with opening 4 and opening 5. Valve elements 2,3 are indicated as located within the housing and intended for opening and closing the opening 4 and the opening 5, respectively.

From FIG. 2 it appears that the openings 4 and 5 in the housing 7,8 are running through a pipe stub extending from the housing. This facilitates the connection of necessary tube elements.

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From FIG. 3 the inner cavity of the pump housing 7,8 appears. The two housing parts 7,8 are sealed along the circumferential edge. In the top part 8 an opening 5 pipe stub is

located. On the side facing the housing inner cavity in the assembled state the two valve elements 2,3 are fastened. The valves can in principle be provided at any location, e.g. on the outside of the housing or within the passage where the opening and closing that need to be controlled. The valve elements each consist of a piezo electric element.

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Each valve element is fastened at a location in a distance from the openings 4 and 5 in such a manner that the valve is closing an opening in one state of electrical influence, e.g. zero influence, and opening the same in another state of electrical influence. The valve is hereby of a type having piezo electrical properties that provide a bending of the valve element upon applying a certain electrical influence to it. In general the valve could have piezo electrical properties that provide any change in the physical dimensions, i.e. a bending of the valve element upon applying a certain electrical influence to it is one preferred embodiment. In the lower housing part 7 one or a series of piezo electrical elements are located in a stacked configuration so as to provide a piston element in the pump housing. Between the piston element and the inner sides of the housing element 7 an elastic yielding sealing is provided. This sealing may be a rubber O-ring or a silicone material or a similar substance.

From FIG. 4 an audiological device incorporating a pump according to the invention is shown schematically. The device comprises a probe element adapted to be inserted into an ear canal of a person to be examined. A tubular element is at first end connected to a corresponding opening in the probe element and at second end opposite the first end connected to the opening 5, of the pump. A tubular element is at first end connected to the opening 5 of the pump housing by means of a T-shaped connecting branch and at second end connected to pressure transducer. The said pressure transducer provides an electrical signal for control electronics for the control of the pressure in the ear canal. Further tubular elements connects the outlet openings of sound output transducers to openings in the probe element and the inlet opening of a input transducer to an opening in the probe element. The output transducers are controlled by control electronics and the input transducer signal is delivered to a signal processor for further processing. In connection with the control electronics and the signal processor a control panel as well as output means, e.g. a display, are provided. The control electronics controls the opening and closing of the valve elements in relation to the piston movement in a manner that

enables the creation of pressures above as well as below the surrounding atmospheric pressure. The piston movement is hereby also controlled by the control electronics. The different modes of operation where the pressures above and below the surrounding pressure are created may be part of an automated test procedure.

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The operation of the pump in a situation where a pressure above the surrounding pressure is supplied to the ear canal takes place in the following manner.

- 1) The probe with the pressure tube from the pump is inserted into the ear canal.
- 2) The valve 5 is closed
- 10 3) The valve 4 is opened
- 4) The piston height is reduced by non- supply of electrical power
- 5) Air is drawn into the pump housing through valve 4
- 6) Valve 4 is closed
- 7) Valve 5 is opened
- 15 8) The piston height is increase by supply of electrical power and the air is supplied to the pressure tube
- 9) Repeating the steps 2-8 with the piston frequency selected

- 20 The operation of the pump in a situation where a pressure below the surrounding pressure is supplied to the ear canal takes place in the following manner.

- 1) The probe with the pressure tube from the pump is inserted into the ear canal.
- 2) The valve 4 is closed
- 3) The valve 5 is opened
- 25 4) The piston height is reduced by non- supply of electrical power
- 5) Air is drawn into the pump housing through valve 5
- 6) Valve 5 is closed
- 7) Valve 4 is opened
- 8) The piston height is increase by supply of electrical power and the air is exited to the
- 30 surroundings
- 9) Repeating the steps 2-8 with the piston frequency selected

Such devices are used for providing audiological tests. One example of such test is the recording of a tympanogram. This test serves its purpose in evaluation of conductive hearing loss and assessment of middle ear function. After a number of initial procedures comprising instructing the patient and initializing the equipment the test procedure may
5 be started. The probe is inserted in the ear canal to be tested. The probe should have an airtight sealing. During the test procedure the pressure is swept from a desired maximum pressure level to a desired minimum pressure level. During this pressure sweep the equipment generates a sound or tone signal through an output transducer, where this signal is reflected by the tympanic membrane and the reflected signal can be
10 obtained by the input transducer adapted for this purpose. The values recorded may be displayed in a X-Y diagram.

CLAIMS

1. A measuring device for acoustic measurement in an ear canal, the device comprising a probe for insertion into an ear canal in a sealing manner and having
5 an opening for transport of air into or out of the ear canal, the device further comprising a pump for providing a pressure difference in relation to a surrounding atmospheric pressure, the pump comprising a housing with openings for inlet and/or outlet, where within the housing a piston element having piezo electric properties is disposed, where one opening in the pump is operatively
10 connected to the opening in the probe.
2. A measuring device according to claim 1, where in connection with the inlet opening and the outlet opening valve elements are provided for controlling the inlet and the outlet and where the valve elements have piezo electric properties.
15
3. A measuring device according to claim 1 or 2, where the pump is adapted to operate at a frequency above 18 kHz, preferably above 20 kHz.
4. A measuring device according to claim 1, 2 or 3, where control electronics are
20 provided for controlling valve positions in relation to the piston movement in such a manner that in one mode of operation a pressure above the surrounding pressure may be obtained and in another mode of operation a pressure below the surrounding pressure may be obtained.
- 25 5. A measuring device according to any of the claims 1-4, where a pressure operated passive valve element is provided in connection with the pressurized parts of the device.
- 30 6. A pump having a housing with an inlet opening and an outlet opening and disposed within the housing a piston element having piezo electric properties, where in connection the inlet opening and the outlet opening valve elements are provided for controlling the inlet and the outlet, where the valve elements are valve elements having piezo electric properties.

7. A pump according to claim 6, where the pump is adapted to operate at a frequency above 18 kHz, preferably above 20 kHz.

ABSTRACT

The invention relates to a measuring device for measuring in an ear canal, the device comprising a probe for insertion into an ear canal and having an opening for letting air in
5 to and out of the ear canal the device further comprising a pump for providing a pressure
above a surrounding atmospheric pressure or below the surrounding atmospheric
pressure, the pump comprising a housing with openings for inlet and/or outlet, where
within the housing a piston element having piezo electric properties is disposed, where
one opening in the pump is operatively connected to the opening in the probe.

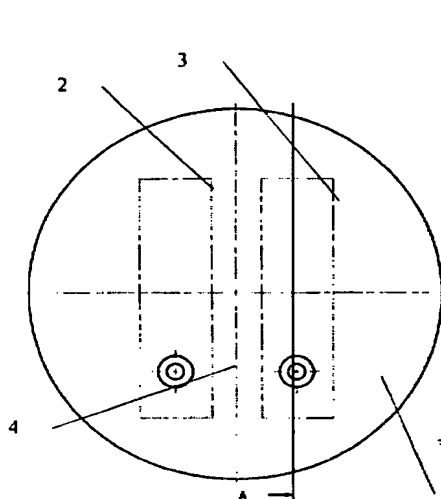


FIG. 1

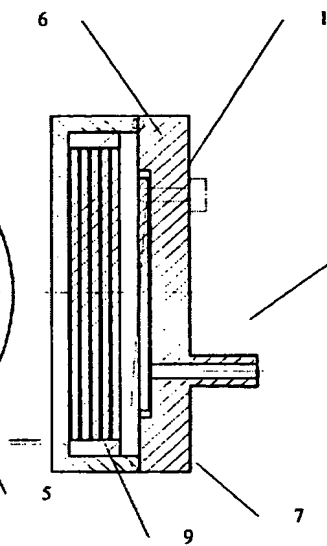


FIG. 3

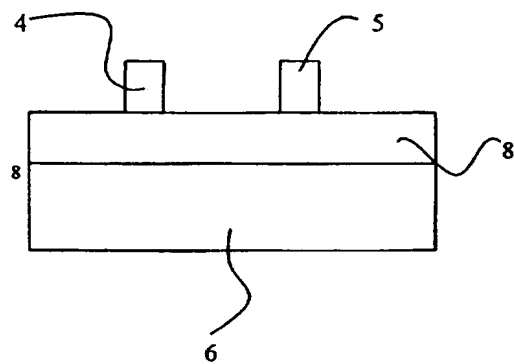
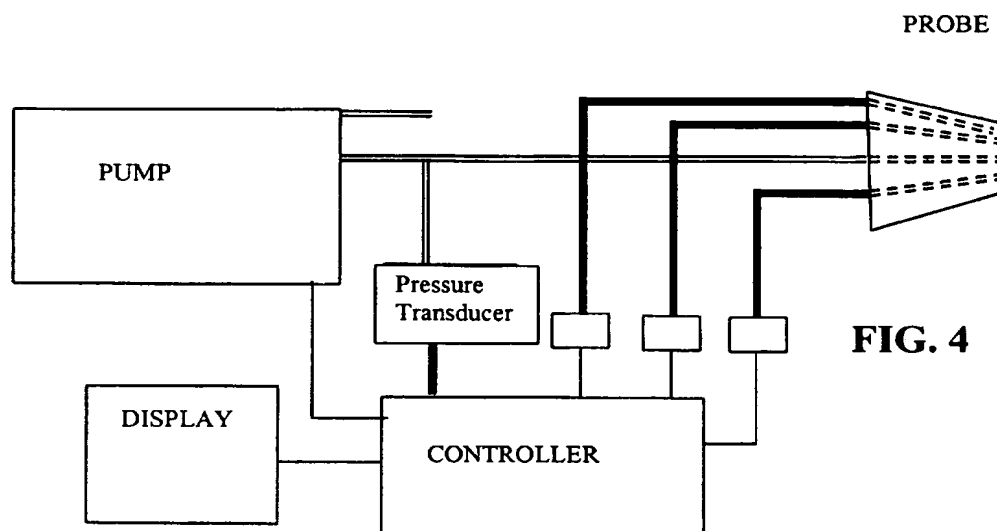


FIG. 2

Modtaget PVS
10 JAN. 2002



PCT

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International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) P-2002-001

Box No. I TITLE OF INVENTION

Piezo electric pump and device with such pump

Box No. II APPLICANT

☐ This person is also inventor

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

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DKState (that is, country) of residence:
DKThis person is applicant
for the purposes of:☐ all designated
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of America only☐ the States indicated in
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Birkholmvej 1
DK-3540 Lyngø
Denmark

This person is:

☐ applicant only☒ applicant and inventor☐ inventor only (If this check-box
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| <input checked="" type="checkbox"/> DZ Algeria | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> EC Ecuador | <input checked="" type="checkbox"/> MN Mongolia | |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> MW Malawi | <input checked="" type="checkbox"/> UZ Uzbekistan |
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The priority of the following earlier application(s) is hereby claimed:				
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: regional Office	international application: receiving Office
item (1) 10. January 2002	PA 2002 00038	DK		
item (2)				
item (3)				
item (4)				
item (5)				
<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.				
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<i>* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):</i>				
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Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):				
ISA / EP				
Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):				
Date (day/month/year)	Number	Country (or regional Office)		
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This international application contains:

(a) the following number of sheets in paper form:

request (including declaration sheets) : 6

description (excluding sequence listing part) :

claims :

abstract :

drawings :

Sub-total number of sheets : 6

sequence listing part of description (*actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below*) :

Total number of sheets : 6

(b) sequence listing part of description filed in computer readable form

- (i) ☐ only (under Section 801(a)(i))
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Number of items

Figure of the drawings which should accompany the abstract:

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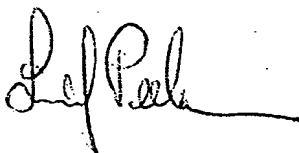
Language of filing of the

international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Interacoustics A/S
Leif Pedersen
Managing Director




Steen B. Rasmussen

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3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
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PCT/DK 03/00011	
International Application No.	
- 9	JANUARY 2003
International Filing Date	
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Applicant's or agent's file reference (if desired) (12 characters maximum) P-2001-024	

Box No. I TITLE OF INVENTION Piezo electric pump and device with such pump	
Box No. II APPLICANT <input type="checkbox"/> This person is also inventor	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.) Interacoustics A/S Drejervænget 8 DK- Assens Denmark	
Telephone No. +45 63713555	
Facsimile No. +45 63713522	
Teleprinter No.	
Applicant's registration No. with the Office	
State (that is, country) of nationality: DK	
State (that is, country) of residence: DK	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
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Appendix 6

PCT/DK03/00011

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- ☐ ☐ ☐
- ☐ ☐ ☐

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that these additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

RO/DK

PCT/DK 03/00011

Sheet No. 3

Box No. VI PRIORITY CLAIM				
The priority of the following earlier application(s) is hereby claimed:				
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: regional Office	international application: receiving Office
item (1) 10. January 2002	PA 2002 00038	DK		
item (2)				
item (3)				
item (4)				
item (5)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:

☐ all items
 ☒ item (1)
 ☐ item (2)
 ☐ item (3)
 ☐ item (4)
 ☐ item (5)
 ☐ other, see Supplemental Box

* Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):

Box No. VII INTERNATIONAL SEARCHING AUTHORITY	
Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen: the two-letter code may be used):	
ISA / EP	
Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):	
Date (day/month/year)	Number Country (or regional Office)

Box No. VIII DECLARATIONS	
The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):	
<input type="checkbox"/> Box No. VIII (i)	Declaration as to the identity of the inventor : Number of declarations
<input type="checkbox"/> Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent : Number of declarations
<input type="checkbox"/> Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application : Number of declarations
<input type="checkbox"/> Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America) : Number of declarations
<input type="checkbox"/> Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty : Number of declarations

Sheet No. ...4...

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) the following number of sheets in paper form:

request (including declaration sheets) : 4 [8]

description (excluding sequence listing part) : 6

claims : 3

abstract : 1

drawings : 2

Sub-total number of sheets : 15 [8]

sequence listing part of description (actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below) :

Total number of sheets : 15 [8]

(b) sequence listing part of description filed in computer readable form

(i) ☐ only (under Section 801(a)(i))(ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained (additional copies to be indicated under item 9(ii), in right column):

This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):

1. ☒ fee calculation sheet2. ☐ original separate power of attorney3. ☐ original general power of attorney4. ☐ copy of general power of attorney; reference number, if any:5. ☐ statement explaining lack of signature6. ☐ priority document(s) identified in Box No. VI as item(s):7. ☐ translation of international application into (language):8. ☐ separate indications concerning deposited microorganism or other biological material9. ☐ sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other))(i) ☐ copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application)(ii) ☐ (only where check-box (b)(i) or (b)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter(iii) ☐ together with relevant statement as to the identity of the copy or copies with the sequence listing part mentioned in left column10. ☒ other (specify): Letter

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Interacoustics A/S
Leif Pedersen
Managing Director

Steen B. Rasmussen

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1. Date of actual receipt of the purported international application:

RO/DK 09 JAN 2003 (09.01.2003)

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

5. International Searching Authority (if two or more are competent): ISA/EP

6. ☒ Transmittal of search copy delayed until search fee is paid

2. Drawings:


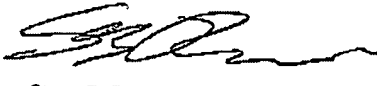
☐ received:☐ not received:

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Date of receipt of the record copy by the International Bureau:

Sheet No. 4

RO/DK 19 FEB 2003

Box No. IX CHECK LIST: LANGUAGE OF FILING		
<p>This international application contains:</p> <p>(a) the following number of sheets in paper form:</p> <p>request (including declaration sheets) : 48</p> <p>description (excluding sequence listing part) : 6</p> <p>claims : 2</p> <p>abstract : 1</p> <p>drawings : 2</p> <p>Sub-total number of sheets : 56</p> <p>sequence listing part of description (actual number of sheets if filed in paper form, whether or not also filed in computer readable form: see (b) below) : 0</p> <p>Total number of sheets : 56</p> <p>(b) sequence listing part of description filed in computer readable form</p> <p>(i) <input type="checkbox"/> only (under Section 801(a)(i))</p> <p>(ii) <input type="checkbox"/> in addition to being filed in paper form (under Section 801(a)(ii))</p> <p>Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained (additional copies to be indicated under item 9(ii), in right column):</p>		<p>This international application is accompanied by the following item(s) (mark the applicable check-boxes below and indicate in right column the number of each item):</p> <p>1. <input checked="" type="checkbox"/> fee calculation sheet</p> <p>2. <input type="checkbox"/> original separate power of attorney</p> <p>3. <input type="checkbox"/> original general power of attorney</p> <p>4. <input type="checkbox"/> copy of general power of attorney; reference number, if any:</p> <p>5. <input type="checkbox"/> statement explaining lack of signature</p> <p>6. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s):</p> <p>7. <input type="checkbox"/> translation of international application into (language):</p> <p>8. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material</p> <p>9. <input type="checkbox"/> sequence listing in computer readable form (indicate also type and number of carriers (diskette, CD-ROM, CD-R or other))</p> <p>(i) <input type="checkbox"/> copy submitted for the purposes of international search under Rule 13ter only (and not as part of the international application)</p> <p>(ii) <input type="checkbox"/> (only where check-box (b)(i) or (b)(ii) is marked in left column) additional copies including, where applicable, the copy for the purposes of international search under Rule 13ter</p> <p>(iii) <input type="checkbox"/> together with relevant statement as to the identity of the copy or copies with the sequence listing part mentioned in left column</p> <p>10. <input checked="" type="checkbox"/> other (specify): Letter</p>
<p>Figure of the drawings which should accompany the abstract: 1</p>		<p>Language of filing of the international application: English</p>
<p>Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE</p> <p>Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).</p>		
<p>Interacoustics A/S Leif Pedersen Managing Director</p> <p></p> <p> Steen B. Rasmussen</p>		

For receiving Office use only		For International Bureau use only	
1. Date of actual receipt of the purported international application:	RO/DK 09 JAN 2003 (09.01.2003)	2. Drawings:	<input type="checkbox"/> received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		<input type="checkbox"/> not received:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):		5. International Searching Authority (if two or more are competent):	ISA/EPO
6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid		Date of receipt of the record copy by the International Bureau:	

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